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(54) IMPROVEMENTS RELATING TO THERMALLY ACTUATED CONTROL VALVES

(71) We, DYNAIR LIMITED, a British Company, of Nailsworth, Gloucestershire, GL6 0JH, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to control valves, and particularly to thermally actuated pneumatic control valves for controlling the supply of compressed air to an actuator such as a pneumatic ram.

The invention is applicable especially to a control valve in a pneumatic control system for a pneumatically operated clutch in the drive to a cooling fan of an internal combustion engine. It is known to provide a thermally controlled clutch in the drive to a cooling fan, to disengage the drive when the temperature of the engine falls below a selected value. This is beneficial to the operating efficiency of the engine and maintains the working temperature at a selected value or within a selected range. The valve of the present invention in its preferred form is designed for use in such a thermally controlled cooling fan drive.

Broadly stated the invention consists in a thermally actuated pneumatic control valve, comprising a valve casing which is closed at one end and has three longitudinally spaced ports in the side wall of the casing, namely an inlet port adjacent the closed end, an intermediate outlet port, and a relief port adjacent the opposite end of the casing, two longitudinally spaced resilient seals located respectively in two annular grooves formed in the inner surface of the side wall of the casing, one seal between the inlet and outlet ports, and the other between the outlet and relief ports, a longitudinally movable valve element within the casing arranged to engage and form fluid-tight sealing engagement with the resilient seals, the effective length of the valve element being equal to or greater than the spacing between the two seals, a thermal actuator located at the end of the casing remote from the inlet port and arranged to engage the movable valve element, so as to move the valve element between a first position in which it connects the inlet port to the outlet port and closes off the relief port, and a second position in which it closes off the inlet port and connects the outlet port to the relief port, the valve element being freely movable also independently of the thermal actuator towards the closed end of the casing.

The overlap provided by the length of the valve element ensures that there will be no direct communication between the inlet and relief ports.

In a particular preferred construction the valve also includes a spring acting on the valve element urging the element towards the inlet port end of the casing.

The invention also consists in a control valve as defined, in combination with a cooling fan assembly for a vehicle engine, the thermal actuator being located in part of a liquid coolant circuit for the engine while the inlet and outlet ports are connected to a pneumatic pressure system for supplying compressed air to a pneumatically operated clutch for the cooling fan.

The invention may be performed in various ways and one specific embodiment will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a sectional side elevation through a thermostatic control valve according to the invention, and

Figure 2 is a diagrammatic illustration of a vehicle motor with a cooling fan and a thermostatic fan control system incorporating the valve of Figure 1.

Referring first to the complete system illustrated in Figure 2, the internal combustion engine 15 is a water cooled petrol or diesel motor arranged to drive the rear wheels of the vehicle (not shown) and the motor is also arranged to drive a cooling fan having a fan hub 12 and a series of fan blades 13. The cooling circuit of the motor includes a radiator 14, through which air is drawn by the fan, a water hose 17, through which hot water from the engine cooling jacket passes into the

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upper part of the radiator, and a return hose 16, through which water cooled in the radiator returns to the engine cooling jacket. A water circulating pump and thermostat valve (not shown) are normally included in the coolant circuit.

The fan hub 12 includes a friction clutch for example of the general type described in British Patent No. 1,310,511, and a pneumatic operating ram, the supply of air to actuate the ram being controlled by a thermostatic valve 10, through which compressed air is delivered from a compressor or other sources of compressed air 11 on the vehicle. Compressed air is supplied to the valve through an input pressure line 18 and is supplied to the fan hub through an output line 19. The valve 10 also has a relief passage 20 communicating with atmosphere. The arrangement is such that when compressed air is supplied to the ram in the fan hub the clutch is disengaged, and when the air pressure is relieved the clutch is automatically engaged by springs within the fan hub.

Referring now to Figure 1, the valve 10 comprises a valve body or casing 25 having a longitudinal internal bore 26, which is closed at one end by an integral end wall and closed at the other end by a thermal sensing element 27, sealed to the casing by a sealing ring 28 and positively located by a locking ring 29, held in position by a swaged lip 30. The capsule 27 contains a wax designed to expand at a selected temperature and to cause a button 31 at the inner end of the capsule to project. The valve is mounted in the hose 16 of the coolant circuit so that the capsule 27 is exposed to the water flowing through the hose.

The casing of the valve 25 has an inlet port 36 connected to the input pressure line 18, a spaced outlet port 35 connected to the pressure output line 19, and a relief port 37 which may be connected to the relief passage 20 or to a simple relief valve as illustrated at 38. These three ports 35, 36 and 37 communicate with the central bore 26 of the valve at longitudinally spaced positions.

Within the valve bore is mounted a movable valve element 40, in the form of a plain smooth surfaced cylindrical plug having slightly tapered extremities 41, 42. Also movable within the valve bore is an actuating plunger 43, having a flat face at its left hand end to engage the element 40, a central recess at its other end to fit over the wax capsule button 31, and a surrounding peripheral wall 47 with a flange 44, which abuts against a cylindrical distance piece 45 fixed in position between a part of the casing 25 and the capsule 27. The valve element 40 is a loose fit in the valve bore 26, and the internal surface of the bore is formed with two annular grooves accommodating O-ring seals 50, 52. The length of the plain cylindrical surface of the valve element is somewhat greater than the distance between the two seals.

Assuming that compressed air is supplied through the inlet port 36 the pressure will drive the element 40 to the right against the force of the spring 46 until the tapered portion 41 of the valve element moves clear of the first 'O' ring seal 50. This permits air under pressure to flow past the seal, through the clearance 51 between the valve element and the walls of the bore 26, and thence through the outlet port 35 connected to the pressure line 19. This admits compressed air to the ram in the fan hub and disengages the clutch so that the fan blades 13 are not driven. The power absorbed by the fan, and also the noise generated by the fan, are thus greatly reduced. The cooling effect is also greatly reduced so that the temperature of the coolant water will tend to rise.

When the coolant temperature reaches a predetermined value there is a rapid expansion of the wax in the capsule 27, and the button 31 extends to the left and engages the plunger 43 which shifts the valve element 40 also to the left. The valve engages the seal 50 thus closing off communication between the ports 36 and 35. Further movement of the valve element to the left causes the right hand end taper 42 to move clear of the second 'O' ring seal 52 thus opening communication between the outlet port 35 and the relief port 37. Compressed air within the ram of the fan can thus be discharged to relief and the fan clutch automatically engages under the action of the springs included in the fan hub.

It will be noted that the effective length of the plain cylindrical part of the valve element 40 is slightly greater than the distance between the two seals 50 and 52. This overlap ensures that the engagement at seal 50 will be completed before contact at seal 52 is lost. In this way direct communicated between the pressure inlet 36 and the relief port 37 is avoided. Also it will be noted that the length of the valve element 40 and the clearance at the left hand end of the valve bore 26 will accommodate considerable expansion of the capsule 27 beyond the position where the seal 50 is first engaged by the valve element.

If there should be a failure of pressure in the supply line 18 for any reason the spring 46 will urge the valve element 40 towards the left thus making contact at the seal 50 and opening communication between ports 35 and 37 past the seal 52. The fan is therefore automatically engaged by its internal springs. This provides a "fail safe" feature.

The spring 46 may in some forms of the invention be omitted.

It will be noted that the valve element 40 is extremely simple to manufacture and requires only external machining operations. The bore 26 of the valve housing requires substantially no machining apart from the two annular

grooves for the 'O' rings 50 and 52. The valve element 40 itself does not make contact with the walls of the valve bore.

WHAT WE CLAIM IS:—

1. A thermally actuated pneumatic control valve, comprising a valve casing which is closed at one end and has three longitudinally spaced ports in the side wall of the casing, namely an inlet port adjacent the closed end, an intermediate outlet port, and a relief port adjacent the opposite end of the casing, two longitudinally spaced resilient seals located respectively in two annular grooves formed in the inner surface of the side wall of the casing, one seal between the inlet and outlet ports, and the other between the outlet and relief ports, a longitudinally movable valve element within the casing arranged to engage and form fluid-tight sealing engagement with the resilient seals, the effective length of the valve element being equal to or greater than the spacing between the two seals, a thermal actuator located at the end of the casing remote from the inlet port and arranged to engage the movable valve element, so as to move the valve element between a first position in which it connects the inlet port to the outlet port and closes off the relief port, and a second position in which it closes off the inlet port and connects the outlet port to the relief port, the valve element being freely movable also independently of the thermal actuator towards the closed end of the casing.

2. A control valve according to any of the preceding claims, including a spring acting on the valve element urging the element towards the inlet port end of the casing.

3. A control valve according to claim 2, in which the spring acts between the valve element and a part which is movable with the thermal actuator.

4. A control valve according to any of claims 1 to 3, in which the valve element has a smooth external surface.

5. A control valve according to any of the preceding claims, in which the thermal actuator is a wax capsule.

6. A control valve according to any of the preceding claims, in combination with a cooling fan assembly for a vehicle engine, the thermal actuator being located in part of a liquid coolant circuit for the engine while the inlet and outlet ports are connected to a pneumatic pressure system for supplying compressed air to a pneumatically operated clutch for the cooling fan.

7. A thermally actuated pneumatic control valve substantially as described with reference to the accompanying drawings.

8. A cooling fan assembly including a pneumatic control valve in accordance with any of the preceding claims, substantially as described.

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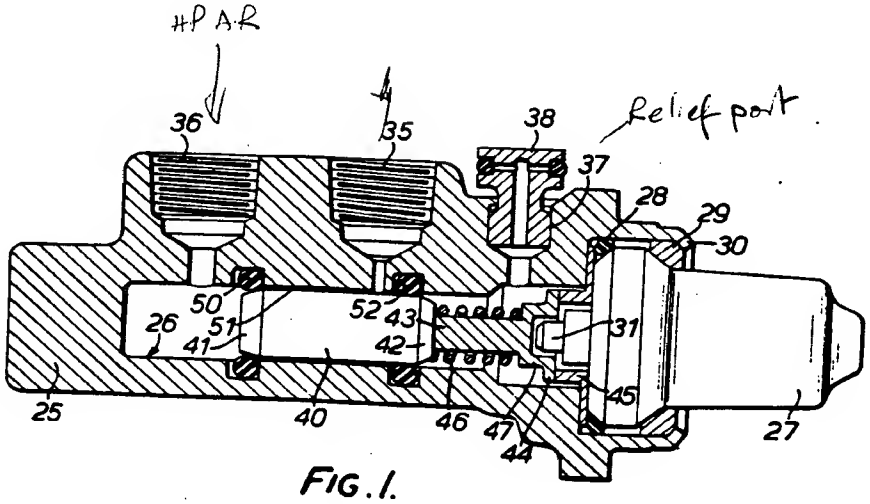

FIG. 1.

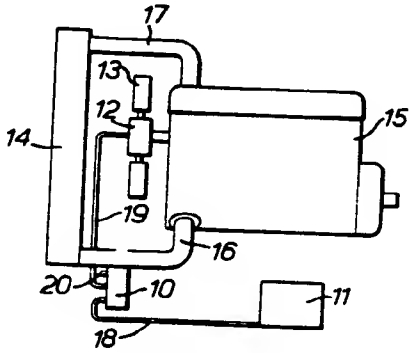

FIG. 2.